TRANSACTIONS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

ARTICLE I.

ON ADIPOCIRE, AND ITS FORMATION.

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THE formation of fat is interesting, both from a chemical and a physiological point of view. The relation of lignine starch and sugar to alcohol, afforded reasons for Liebig's theory of the formation of fat in the body. Recent experiments by Liebig, Bopp, Guckelberger, Keller and others, on the formation of the lower terms of the series of fatty acids by the oxidation and putrefaction of the blood-forming substances, rendered possible the formation of the higher members, from albumen, fibrin and caseine, by similar means,* for example, by a less intense degree of oxidation. It was thought that the study of adipocire, with a view to this question, would perhaps throw some light upon it; and upon reading all the articles within my reach, upon this body, from the time of its discovery by Fourcroy, I find a considerable difference of opinion with regard to it.

In 1785, Fourcroy examined a portion of a liver which had hung for ten years in the air in the laboratory of de la Salle; it was fatty, smooth, and unctuous to the touch. Potash ley dissolved a portion of the liver completely, forming a soap. Subsequently, when he had examined the fat of grave yards, and spermaceti, he proposed to name these three fats,

* Liebig thinks this probable. Ch. Briefe.

viz.: of biliary calculi, spermaceti, and from grave yards, adipocire, considering them to be identical, and possessing an intermediate nature between fat and wax. Chevreul, in his fifth Memoire, corrects this error, and calls the fat of gall stones cholesterine, and that of spermaceti cetine.

In 1786–7, Fourcroy had an opportunity of studying the fat of grave yards, in the removal of the bodies from the Cemetière des Innocens, a work which lasted for two years, and which was supervised by Dr. Thouret, who was placed there to care for the health of the workmen. The substance was abundantly found, and especially in the "fouilles," or ditches, where the slightly made coffins of the poorer classes had been piled one upon another; the trench being open for some time until it was filled with bodies, when it was covered with a slight quantity of earth; on opening the trenches after some fifteen years, the bodies were converted into adipocire; they were flattened by mutual pressure, and had impressions on their surface of the grave clothes. Fourcroy's analysis proved it to be a soap of ammonia, with phosphate of lime, and the fat, melted at 52° 5 C.* He supposed adipocire to arise from the putrefaction of all animal matter, except hair, nails, and bones, for he states that in the carcasses of all animals exposed upon the borders of pieces of water, a fatty, white, fusible substance resembling spermaceti is found.

Perhaps the earliest record on this change from flesh to fat, is to be found in Lord Bacon's Sylva Sylvarum, where he says, (article Fat,) "Nearly all flesh may be turned into a fatty substance, by cutting it into pieces and putting it into a glass covered with parchment, then letting the glass stand six or seven hours in boiling water." This may be a profitable experiment for making fat or grease; but then it must be practised upon such flesh as is not edible, viz.: that of horses, dogs, bears, foxes, badgers, &c.

George Smith Gibbes, 1794, observed that in Oxford, in the pits where were thrown the remains of dissections, and at the bottom of which flowed a gentle current of water, large quantities of adipocire were formed. He placed a piece of beef in the river in a box pierced with holes, and also a piece in which putrefaction in the air had commenced, and adipocire resulted in both cases. He proposes to make use of this property to utilize the dead bodies of animals, and states that nitric acid will effect the same change in three or four days.

John Bostock (Nicholson's Journal, March, 1803,) digested muscular fibre with dilute nitric acid, and washed with water: the result was a clear, yellow fat, of the consistence of tallow, melting at 33° C. Is less soluble in alcohol than Fourcroy's substance: the greater part deposits nearly white on cooling, and the residue can be precipitated from the alcohol by water. Hot ether dissolves it and abandons it on cooling; caustic alkali forms a soap; ammonia dissolves but little of the fat.

* The degrees of thermometer in this article are centigrade, and the weights grammes.

Chevreul, on repeating this experiment with pure fibrine, could obtain no fat. Hartkol, (Ure's Dict. art. Adipocire,) experimented for twenty-five years on adipocire, and concluded that it is not formed in dry grounds, that in moist earth the fat does not increase, but changes to a fetid mass, incapable of being made into candles. Animals in running water leave a fat after three years, which is more abundant in the intestines than in the muscles, and more fat is formed in stagnant, than in running water.

Chevreul, 1812, found the fat of church yards to contain margaric and oleic acids, combined with yellow colouring and odorous matters, also lime, potash, oxide of iron, lactic acid salts and azotized matter. He supposes the fatty acids are liberated from their glycerine by ammonia, which subsequently itself escapes, and that adipocire is thus formed from the original fat of the body.

Gay Lussac, (An. de Ch. et de Ph. iv. 71,) adopts the same views. He subjected finely chopped muscular fibre deprived of its fat by ether, to the action of water, and did not succeed in forming adipocire.

Von Bibra, (Annalen der Chem. und Ph. 56, p. 106,) in an examination of the flesh of the leg of a Peruvian mummy, a child, obtained 19.7 per cent. of fat, which he supposes to have been formed from the muscles. In comparison, dry human muscle from several analyses by himself, gives nine per cent. of fat. The muscular fibre of the mummy, after treatment with ether, presented the same appearance under the microscope, as fresh muscle placed in the same circumstances. Bibra states in the same article, that he is fully convinced of the change of muscle to fat, having obtained a human corpse in which all the parts of flesh were nearly wholly converted into fat.

Blondeau, (Comptes Rendus, Sep. 6th, 1847, and Ch. Gazette, same year, p. 422,) arrived at the same conclusion from an examination of the Roquefort cheese manufacture. This cheese is placed in dark, damp, cool cellars to ripen. Before this treatment, the cheese contained $\frac{1}{200}$ of its weight of fat, and after two months in the cellars the caseine was almost wholly converted into a fat, which melts at 40°, boils at 80°, and decomposes at 150° C. The unaltered caseine could be removed from it, by mere melting with boiling water. In an additional experiment, a pound of beef free from fat was slightly salted, surrounded with paste, and placed in a cellar; after two months, it had undergone no putrid decomposition, and was converted, for the greater part, into a fatty body, presenting the greatest analogy to hog's lard. In these instances a number of parasite plants are observed on the material, and it is necessary to scrape the cheese from time to time, to free it from these mycodermic plants, which are reproduced with fresh energy. As these plants require ammonia for their development, Blondeau supposes it can only come from the nitrogen of its caseine, and that fat is one of the results of the caseine decomposition.

Gregory, (Annalen der Chem. und. Ph. 61, p. 362,) examined the adipocire of a fat hog

which had died of sickness, and had been buried for fifteen years in moist ground; at the bottom of the grave was the adipocire in a layer hardly an inch in thickness; it contained ¼ stearic and ¾ margaric and oleic acids, together with from 1. 5 to 3.5 per cent. lime. The glycerine was all gone, and so was the bone earth, which together with the flesh were removed, as Gregory supposes, by the carbonic acid of the rain water, leaving the original fatty acids of the body.

Prof. Hünefeld, (Jour. für Pr. ch. 7, p. 49,) examined a loaf of rye bread, which had been buried for at least eighty years in a turf-moor, and found 2.2 per cent. of a waxy or fatty substance, and he refers to an examination by Bracconot, of a mouldered wheat bread containing, among other substances, a fatty body. Hünefeld supposes that the substance of the bread was displaced by the turf material, the form of the loaf being retained; and admits the possibility of the bread substance partaking in part a change into resin and waxy humus.

R. Wagner, (Ch. Gazette, vol. 9, p. 306,) transplanted the recently removed testicles of rabbits and frogs into the abdominal cavity of fowls; the testicles of fowls into other fowls and pigeons, those of pigeons into fowls, and fresh crystalline lens into fowls and pigeons which were killed after ten or fifteen days. The testicles of frogs contained three per cent. of fat, which was augmented to 5.15 per cent. In one case the crystalline lens, after the experiment, contained 47.86 per cent. of fat; in a number of other experiments on lenses, the result was of from 7 to 15 per cent. of fat, calculated for the dry substance of the lens; carefully cleaned portions of frog intestines filled with coagulated blood of pigeons and calves, fat free muscle from the thigh of a frog, and boiled white of hen's egg, in similar conditions, all gave fat.

These experiments were repeated by Husson and Burdach,* enveloping the nitrogenized substances in bags or coatings of gutta percha, caoutchouc and collodion. They found the substance well preserved, but no change into fat; so that admission of the animal juices must conduce to it, if the change be possible. Burdach placed porous vegetable substances, as wood and tinder, in the abdominal cavity, and found a deposit of fat on them, and which was imbibed in the pores, which speaks against the change in question. Finally, Burdach determined the fat of the egg of *Linnæus stagnalis*, and detected a considerable increase of it during the development of the embryo; but, on the other hand, the egg contains sugar from which the fat could have been formed; and in opposition to this the quantity of sugar in hens' eggs has been noticed rather to increase than diminish during incubation.

Quain & Virchow quoted by Lehmann,† examined muscle changed in macerating troughs to adipocire, and are of opinion that the fibrine is here changed to fat. I have questioned

* Lehmann, Lehrbuch. † Lehrbuch, III. p. 187.

my medical friends, who have had experience in this matter, and find them to hold the same opinions. Prof. Leidy, who macerated with water the bodies of small animals, in stoppered bottles, to obtain their skeletons, found that the deposition of adipocire upon the bones was quite abundant.

The physiological question of the formation of fat, has been fully discussed within the past ten years, and it has been proven by diet and analysis, that herbivorous animals possess more fat than is taken in their food; but whether the fat be formed wholly from non-nitrogenized or from nitrogenized bodies, or partially from both, is yet undecided. Pathological considerations from the fatty degeneration of several of the organs, where the fat is found both within and without the cell,* appear likewise to have divided scientific men as to its origin, whether from a change of the proteine compounds of the organs, or from an abnormal plastic activity. The connexion of the organs of generation with the deposit of fat, and the increase of the latter after castration, is worthy of consideration; for the cutting off the supply of the highly albuminous semen, gives an impulse to the fat formation. The flesh and the fat of the body stand in an intimate relation to each other, and neither the non-nitrogenized nor the nitrogenized diet exclusively is conducive to health. *Repose* is necessary, (with a proper diet,) to the formation of fat, and as the activity of the muscles requires their reparation from the food, perhaps it is as much this wearing away by activity, that hinders the formation of fat, as the increased combustion by the quickened respiration. It therefore appears to me probable that both classes of food conduce to the fat formation.

It was thought that the study of adipocire would throw some light upon the question, whether fat be formed from proteine compounds, and I was surprised to find the great difference of opinion as to the formation and nature of this body, and in general, as to the changes that bodies undergo in grave yards. These various changes are ascribed by undertakers to the nature of the soil, to its dryness or moisture; but in a late removal of a grave yard in this city, some bodies were found converted into adipocire, the graves of which were contiguous to those in which decomposition had advanced to its full extent, leaving nothing but the skeleton. The preservation of some bodies seems inexplicable, according to our present knowledge, of which I may cite the well known case of General Washington, (who was not embalmed,) who having reposed in his tomb for more than forty years, was so perfectly preserved, as to have been recognised from the resemblance of his portraits. The problems proposed for this research were:—

1st. The chemical examination of different kinds of adipocire.

2d. To watch the decomposition of flesh with water, and imitating the condition of a body in moist ground.

* Lehmann.

With regard to the first of these, I possessed the following specimens of adipocire:

(*a*) Two from sheep buried at the country seat of the late J. P. Wetherill.

(*b*) Two from human subjects, which I obtained myself from a grave yard.

(*c*) From a fossil ox, presented by Prof. Leidy.

(*a*) SHEEP ADIPOCIRE.

Specimens of this adipocire were presented to the Academy of Natural Sciences, by my uncle, who found them at his country seat, opposite Valley Forge, buried in moist ground, near a drain which led water from a spring-house. About ten years previously, the shepherd in charge of a flock of sheep indulged in a drunken spree, and in the meanwhile some fifteen of the sheep in his care died from neglect, and were buried in the above mentioned spot. My uncle, who was present at the exhumation of the sheep, stated that in some of the remains, the exterior forms of the muscles were very distinct. The two specimens I obtained were in lumps, amorphous under the microscope, floating on water; of greasy feel, and rank mutton smell, mingled with a peculiar disagreeable fundamental smell, that I have observed in all my specimens of adipocire, including the fossil one. Heated in a capsule with water, a transparent fat floats melted on the surface; heated alone in a platinum crucible, it melts and burns with a smoky flame, leaving a slight residue, which effervesces with hydrochloric acid, and contains beside sand and a little iron, principally lime. Under the microscope with moderate powers, it is white, fatty, and granular, disappearing with Canada balsam; with higher powers it is amorphous: melted on the glass slide covered with thin glass, is crystalline on cooling, in groups of plumose crystals, which give a beautiful play of colours with polarized light; a drop of its weak alcoholic solution evaporated spontaneously on glass gave the same appearance of crystallization. Water added to this solution precipitated it in the form of a pure white amorphous powder: distilled per se, leaves a slight carbonaceous residue, and gives a volatile fat, yellowish, and cryst, on cooling. This volatile fat is soluble in hot alcohol, and precipitates partly on cooling. The weight of material was seventy grammes; it was melted in the water bath, and filtered through paper in a hot funnel; the filtered solidified fat was of a light coffee colour, and weighed fifty-four grammes; in a capillary tube, is soft at 54°, fluid at 62°; on cooling becomes opaque at 50°. When pressed in paper, the latter is greased by oleic acid; it contains no ammonia, nor any nitrogen by the potassium test; the residue on the filter (together with the filter) was boiled with alcohol, filtered hot on a weighed filter, and washed with alcohol. This alcoholic solution deposited twelve grammes of fatty acid, by spontaneous evaporation, during the summer. The crystals at first deposited were white and warty; a portion of the alcoholic solution on a glass slide, exhibited with the microscope, white, curved dendritic forms, arranged stellate; in the capillary tube, they begin to melt at 53°,

are fluid at 62°, and on cooling begin to cloud at 58°, and are opaque at 50°. The residue on the filter weighed about four grammes, and viewed under the microscope, consisted of membranous matter, wool, dirt, and the white element of cellular tissue; it gave ammonia with potassa solution, and nitrogen by Laissaigne's test, together with a strong smell of phosphuretted hydrogen when the water was added in the latter test. This residue burned, gave thirty per cent. of ash. The following is the per centage result for the adipocire:—

Solid fatty acids, a little oleic acid, and coally matter,	94.2
Membranous matter and cellular tissue,	2.3
Ash and dirt,	3.5
	100.0

The portion of fatty acid which passed through the filter by melting, contained 0.73 per cent. of a dark-coloured ash, principally lime, with iron, and traces of phosphoric and sulphuric acids, potash and soda. The potash and soda were detected by Dr. Lawrence Smith's beautiful method by polarized light, which I have frequently used with success. In this instance, the quantity of material was so small, that neither the potash nor soda could be detected by the usual method.

[An experiment was tried to ascertain whether the fatty acids would dissolve phosphate of lime. About six or eight grammes of fatty acid, (the residue from the hot press of the candle factories, crystallized from much alcohol, and of which one gramme left no appreciable ash by experiment) were kept for half an hour melted with pulverized bone ashes. One gramme of this gave an ash of only a quarter of a milli-gramme; when this was dissolved in hydrochloric acid and neutralized by ammonia, it was impossible to conclude whether there was a precipitate or not.]

Sixty grammes of the fatty acids were then saponified with potash ley, according to Chevreul's proportions, during which operation neither ammonia nor cholesterine could be detected. The soap was decomposed by tartaric acid, and washed several times by melting with water; it dissolved thus in alcohol with reddish brown colour, and after filtering hot, was suffered to deposit the greater part of its fat on cooling. The crystals thus deposited were nacreous scales, and of lustre like the feathers of moth wings; when melted, they weighed 26 grammes, and had a goat-like smell; by further standing, the alcohol deposited four grammes of very translucent crystals, with traces of stellar groupings. A third crop of crystals by spontaneous evaporation was obtained, which was small in quantity, weighing 0.6 grammes, and, when melted, cooled with a flat, waxy, surface, with traces of stellar aggregations. The mother alcohol of this last crystallization, was treated with an alcoholic solution of acetate of lead. The lead salts, treated in the usual manner by ether, yielded a few drops of very highly coloured oleic acid. From the insoluble lead salts, the fat was separated.

The alcoholic solution from which the oleate and other lead salts were precipitated by acetate of lead, was evaporated to dryness, and treated by ether, when another portion of oleic acid was obtained. It results from this that the quantity of oleic acid in the adipocire is small. The greater portion of the lead salt was insoluble in ether and alcohol, its fat was separated and added to the first crop of crystals which fell from the alcoholic solution of the fat from saponification. To ascertain whether any glycerine was in combination with the fatty acids in the adipocire, the aqueous solution from which the crop was precipitated by tartaric acid during the purification of the fat, was heated, filtered from small fat globules, and after removing the tartar deposit, subjected to distillation. The acid residue of the retort was neutralized by carb. potash, and after evaporating on the water bath was exhausted with absolute alcohol, which proved the absence of glycerine, as it gave on evaporating nothing but a small residue of colouring matter, which was yellow, and of a bitter taste.

The distillate in this experiment had a goat-like smell, and it was doubtful whether it reacted acid to litmus paper. Baryta water was added to alkaline reaction, for which but a small quantity was needed, and the solution evaporated. There was but little residue, which, on the addition of a drop of hydrochloric acid and water, emitted a rancid smell, but no oil globule appeared; the volatile fatty acids may, therefore, be considered to be present in the adipocire only in faint traces.

The following melting points were obtained:—The first crop of crystals from the alcoholic solution of the fat after saponification, which, when melted, cooled with a stellated surface, tried three times by dipping the thermometer bulb in the melted solution, and noting the temperature when it became opaque, gave 55° for the solidifying point. In a capillary tube, begins to melt at 57°, fluid at 59°, on cooling, opaque at 55°; this portion was taken from the capsule on melting the fat, before the whole mass was melted: another portion taken when all was fluid, and after stirring, gave the same results.

The crystalline appearance of the second crop of crystals from the alcoholic solution after saponification, when melted and suffered to cool in a capsule, is similar to that of the first crop; in the capillary tube, begins to melt at 53°, fluid at 54° 55°, on cooling, crystals form in the tube at 51°, and is opaque at 50°. The melting point of the third crop of crystals was 50°.5. In ascertaining the melting points of the different fats described in this paper, I tried the various modes in use, and settled at first upon the following:—A beaker of distilled water (which must be boiled just before using, to prevent air globules settling upon the capillary tubes, which would falsify the result) is placed upon wire gauze upon a retort stand in front of a window, the thermometer hangs, by a string, in this water from another stand, and the lamp must be moveable from under the beaker glass. A piece of string is tied so loosely around the top of the (cylindrical) mercury

reservoir of the thermometer, that the different capillary tubes may be readily slipped in and out on raising the thermometer from the water; the heat from the lamp must be such that the temperature of the water rises gradually; the capillary tubes are so placed that they lie closely to the mercury of the thermometer, and when the temperature approaches the melting point, the water is stirred with the thermometer to equalize the heat, the lamp is then removed, and the point of solidification observed in the usual way. I doubt very much the use of noting the point of solidification, as it is influenced so much by extraneous circumstances. The cooling of water and certain salts below their solidifying points, is well known, and the same must take place in these instances. Heintz has noticed how the thermometer rose ten degrees in determining the solidifying point of melted human fat. In one of my experiments, the fat in the tube was separated by minute air globules into three or four columns, quite close together; in observing the fusing point, they all melted at the same instant; but in solidifying, one would be quite clear while those on either side had become opaque, no matter how much the tube was stirred or vibrated by striking the beaker glass. After having observed this in several instances, I abandoned taking the points of solidification, and modified the process for the fusing point, by keeping the water as near that point as possible, and repeatedly lifting the thermometer and attached capillary tube out of the water for a few seconds, that the fat might solidify, and noting the fusing point as that at which it at once becomes liquid; this point is reached twice; first, when the water is being heated, and secondly, as it is cooling: I have found by repetition of the same experiment, that the degree thus obtained, is constant from the first, and I think gives the most accurate results. The mode of using capillary tubes for the fusing points, is convenient, as, at the close of the experiment, they can be sealed at the open end, and placed on a card with descriptions, for future reference. I weighed the quantity of fat in one instance, and found that half a milligramme was much more than enough to obtain the melting point with the capillary tube.

(*b*) HUMAN ADIPOCIRE.

Towards the close of the year 1853, I visited a grave yard in Philadelphia, the remains of which were being removed, and from which, through the kindness of the superintendant, I obtained specimens of adipocire and valuable information. The surface of the burial ground was depressed about four or six feet below that of the neighbouring streets, and was of a very moist nature. Many of the bodies were converted more or less into adipocire, and of these, all had been large persons. There was none among the remains of children. I obtained specimens from two persons.

No. 1, was from a large man, which had been buried from ten to fifteen years; the

ground was very moist, and the coffin rotten; the grave was seven feet deep. The adipocire was from the middle of the coffin, and was in irregular lumps.

No. 2, was from a very large man; buried five or six years; the ground moist, though not so much so as number one; the grave five feet deep. The ground around the coffin was of a bloody colour, and all of the body was decayed, except the lower portion. The shape of the rump was plain, and the legs separate; the fat was at the bottom of the coffin, and the bones (femur, tibia) were lying along it. The adipocire contained an impression of the bone, was spongy and dark-coloured on the inside; and on the outside it was smooth, white, and presented impressions of the grave clothes, and here and there appearances as if of the hair follicles and sebaceous glands, but which lost this appearance when viewed with the microscope. There was no hair on this specimen. The pieces of adipocire of this specimen were large, at the thickest part being about three inches in thickness; they presented the shape of different parts of the leg, though flattened; tough fibrous bands, like aponeuroses, were seen in some parts traversing the mass of fatty matter.

The appearance of these two specimens with the microscope, was very similar to each other and to the sheep adipocire. Powder scraped from them, with a fine needle, gave no appearance of fat globules, but irregular masses, mingled with membranous matter; a portion sliced off with a sharp knife, presented by reflected light, brilliant, white, irregular fatty fragments, but no traces of globules. When alcohol was added with heat, the fat disappeared, leaving membranous matter, and fibres not-anastomosing (the white element of cellular tissue.) The addition of acetic acid causes the fibres to disappear, and without showing nuclei.

Portions of number one presented an appearance as if of the hair follicles, and there were mingled with it cylindrical hairs, of an inch and a half in length, brownish in colour, and quite fine. From these hairs, and from its position in the coffin, adipocire number one probably came from the abdomen. The fat from this portion gave the same appearance under the microscope, as specimen number two. The alcoholic solution of the fat evaporated on the microscope slide, gave the appearance of stellated dendritic crystals, with curved branches, resembling the so called margaric acid under the same circumstances.

The whole mass of fat in the two specimens, seems to be entangled in a web of disintegrated membrane, and fibrous tissue. I have never been able to detect any traces of muscular fibre under the microscope; and Dr. Leidy, who was kind enough to examine specimens with the microscope, communicated to me the same results. The smell of the two specimens was peculiar; what might be called an adipocire smell; for I have observed it in all specimens of adipocire that I have examined. This smell is indescribable, the nearest approach to it being that of fæces, but it is much more disagreeable.

The following melting points were observed from the original adipocire, melted per se in

watch glasses, and the fat taken up in capillary tubes. In these specimens, (*a*) was taken from parts with *little*, and (*b*) from parts with *much* cellular tissue:

No. 1.	(*a*)	fuses at 56°	
		solidifies 50°	
	(*b*)	fuses 50°	
		solidifies 43° 44°	
No. 2.	(*a*)	fuses 55°	
		solidifies 50°	
	(*b*)	fuses 55°	
		solidifies 50°	

They commenced to melt a little below and to solidify a little above these points, which were taken for perfect fluidity or opacity. Generally in solidifying, the crystallization commenced at one point, and spread gradually through the capillary tube.

The density varied with different portions of one and two, from below 0.7487 to 1.0, and was ascertained, by immersing specimens (freed from external air globules) in ether of the above density, alcohol of density 0.8365, and distilled water. The ash, no doubt, varied also; but the following determinations were made with the whitest portions of one and two: viz.: those of the density of ether. No. 1, contained 0.573 per cent. of ash, (1.135 gave 0.0065) which effervesced with acid, and contained principally, lime, with traces of chlorine, sulphuric and phosphoric acid, also iron, potassa soda, and (doubtful) magnesia. The melting point of this portion was 52°, 53°. No. 2, gave 0.18 per cent. of ash, (1.109 gave 0.002) which contained the same substances as number one. The melting point of this fat was 53°, 55°.

The two specimens of adipocire were melted with about one and a half times their weight of ordinary alcohol, filtered hot, washed a couple of times with hot alcohol, and pressed, the residue being weighed. This gives an approximate per centage of the membranous and fibrous matter, which is rather too low, owing to a little fat remaining in the residue and filter. The specimens of adipocire were picked as far as practicable from dark pieces.

No. 1, 360 grammes, gave nine of residue, or a per centage of

Fat colouring matter and water, . .	97.8
Organic tissue, ...	2.2
	100.0

No. 2, 997 grammes adipocire, gave twenty-seven residue, or per cent.

Fat colouring matter and water, . .	97.3
Organic tissue, ...	2.7
	100.0

The fats were then saponified with Potassa; No. 1 by Chevreul's process, and No. 2 by Heintz's process with alcohol. The soaps were precipitated several times, by solution of common salt; no ammonia nor cholesterine were detected during the process; a heavy, flocculent soap fell during the melting, which was examined, and found to be a soap of alumina, oxide of iron and magnesia; probably from impurities in the salt. No glycerine was present (by direct experiment) in either of the specimens. An examination for volatile fatty acids, gave negative results for number one, and a very slight trace in number two of volatile fatty acids, acetic and butyric, and one or two minute floating oil drops, most probably from the alcohol employed.

The fats thus obtained, were very dark in colour, and when cooled, after being melted in a capsule on water, solidified with a smooth, waxy surface, with the fibres of crystallization vertical. At the point of crystallization, the expansion pushed up, and broke the soft cake of fat in the centre. No. 1 weighed 237 and No. 2, 644 grammes.

No. 1, (the melting point of which was 57°5, the solidifying point 52°) was melted with an equal weight of alcohol, and on cooling, filtered and pressed; a very dark liquid ran through, a drop of which, evaporated on a glass slide, gave dendritic, stellate, polarizable crystals. To the residue weighing 177 grammes, 100 grammes of alcohol were added, and the fat which separated, together with some depositing from the last filtrate by standing, were added to the fat of the previous operation; the fat which separated from this solution of 177 grammes, melted at 59°–60°, and solidified at 53°–54°. The dark-coloured alcoholic liquid, filtered from these fats, was saponified by an alcoholic solution of potassa; the alcohol expelled by boiling with water, and after transferring to a retort, was boiled with sulphuric acid. The distilled water, examined for volatile fatty acids, gave negative results. The fat was very dark in colour, melted at 55°, and solidified at 50°, though it was difficult to determine these points exactly, as the change exhibited itself very gradually. A portion of this fat was converted into a potassa salt, and precipitated by chloride of barium; the filtrate from which, treated with hydrochloric acid, gave a small quantity of a yellow fat, not further examined.

The baryta salts were treated by ether, and the residue by boiling alcohol. The ethereal, alcoholic solutions, and the residue, were severally decomposed by hydrochloric acid. The ethereal solution gave a small quantity of oleic acid, in very dark drops. The alcoholic solution fat was also small in quantity, and dark. It fused at 61°–62°, and solidified, as well as could be judged, at 45°. The residual fat, which was the largest in quantity, yellow, and of a waxy surface, melted at 43°–46°, and solidified at 45°–40°.

The purification of fat No. 2, was now undertaken, and experimented upon more particularly than No. 1, since this specimen of adipocire conformed to the shape of part of the human frame.

1°. An equal weight of alcohol was added, and the fat, which weighed 644 grammes, was dissolved by heat; on cooling it was pressed, and as the filtrate deposited more fat on standing, it was pressed again, and the fat added to the former. The dark-coloured filtrate was bottled, and the fat melted. It was of smooth and waxy surface, and weighed 511 grammes.

2°. The fat from 1° was melted with 170 alcohol, and the same operation performed. Residue weighed 327 grammes.

3°. Added 124 alcohol to this fat. In this all the liquor was absorbed by the pressing cloths; the fat weighed 335 grammes.

4°. Added an equal weight of alcohol and melted; pressed after two days. The liquid by this time, was light yellowish; the fatty crystals in white flakes or scales; the smaller ones transparent under the microscope, and polarizable. A portion of the fat was melted, and observed cooling under the microscope with polarized light; as the solidification approached, a beautiful play of prismatic colours took place, and the drop shot into crystal interlaced lamellæ. A drop melted with alcohol, and let cool, gave the peculiar dendritic curved appearance of margaric acid.

5°. The fat by this time weighed 300 grammes; it was melted with an equal weight of alcohol, and pressed the following day. Residue, 253 grammes.

6°. This was melted with 250 alcohol; the liquid from the press was very little less coloured than the last; the residue weighed 227 grammes, and was brilliant white, with a tinge of yellow; the fracture showed large crystals, and could not be distinguished from the product of the stearic candle factories. When melted, it cooled with raised, uneven surface, and was completely soluble in ether. When the ethereal solution was suffered to separate spontaneously, the first fat which made its appearance melted at 60°, solidified at 55°, and the fat extracted from the rest of the ether gave exactly the same points.

The following are the melting points yielded by the fatty residues of the foregoing alcoholic crystallizations:

Fat 2° . . .	melts 58° . .	solidifies 53°
" 3° . . .	" 58° . .	" 53° a 52°
" 4° . . .	" 58° . .	" 53° a 52°
" 5° . . .	" 58° a 58° 5 .	" 53°
" 6° . . .	" 60° . .	" 55° 54°

The examination of the liquids separated from the above crystallizations, was now taken up. Their colour was from a very deep reddish brown (No. 1°) down to light yellow, and nearly colourless (No. 6°.) In 1°, 2°, and 5°, crystals had deposited by standing, and as 2° was not corked like the rest, the deposit here was abundant; it was re-melted with addition of as much alcohol as had evaporated, and was suffered to stand for several days

longer, when a drusy crystalline deposit made its appearance. The following are the melting points for these two precipitates:

Precipitate in 1° . .	melts 62° 63° . .	solidifies 44° 5—40°
" " 5° . .	" 51° 53° . .	" 44° 5—43°

The fat deposited in 2° melted at 58°, and solidified at 52°, and the fat separated from the *liquid* of this bottle, melted at 59° 5, solidified at 53°, but continued translucent down to 33°. After the above melting points, 1° and 5° were observed, the same fat was raised slowly to the melting points, and then kept for a considerable time in the thermostat, at 100°, the points were again determined, and found to be the same.

The liquids separated from the fats 1°—6°, gave the following results:

The fat from Liquid 1° . .	melts 36°—46° . .	solidifies 41°—?
" " 2° . .	" 39°—41° . .	" 37°—35° 5
" " 4° * . .	" 59°—62° . .	" 40° 5—35°
" " 5° . .	" 62°—66° . .	" 58°—53°
" " 6° . .	" 53°—56° . .	" 41°—?

The melting point of liquid 2°, does not accord with that above stated, but I note the experiments as they were observed, merely mentioning that I observed carefully, and am not conscious of having made an error. The above points seem vague, but it was impossible to fix a point definitely, as a cloudiness persisted up to the highest degree stated, so I prefer to give the limits of certainty. In 1° and 6° the solidifying points, 41°, were taken when the liquid in the capillary tubes seemed to become solid, but it remained translucent for a long time below this point, and 6° only became opaque (and that gradually) when suffered to stand in the air.

We are reminded here of Duffy's observations upon certain isomeric transformations of the fats, (Quar. Jour. Ch. Sec. V. 197.) He noticed that stearine heated 1° above its point of solidification, became transparent, but soon after resumed its opacity; and Heintz made a similar observation. Duffy attributes this to an isomeric transformation of the fat by the heat; but it seems to me simpler until an isomerism be more distinctly proven, to assume a mixture of fats, which unite to form a definite compound under the circumstances, and which has the above mentioned property.† Heintz's researches on the fats should make us look with suspicion upon fats as pure, that are only purified by crystallization.

* The liquid from No. 3 was all absorbed by the pressing cloths, and not collected.

† Since the above was written, I have received the Journal für Pract. Chemic., Heft III. Band LXIII. in which some late results by Heintz on this point are communicated. He artificially prepared chemically pure stearine from the acid and glycerine, by Berthelot's process, and found that it had two melting points, first at 55°, then solidifying and melting again when the heat reached 71° ·6.

Duffy's remarks were made upon the glycerine compounds of the fatty acids; it appears from the above examination of the liquids 1° and 6°, as if something similar took place with the fatty acids themselves, although, with one or two exceptions, in other determinations of melting points noted in this article, I have not observed the same phenomenon of transparency.

A few experiments were now made with the alcoholic liquid 6°. A concentrated alcoholic solution of acetate of magnesia added to this liquid, produced no precipitate, but micaceous crystalline scales fell on adding acetic acid, and upon adding more acetic acid, and heating, besides these crystals, an oil floated on the surface, which solidified on cooling, and which behaved like a fat, and gave the melting point of palmitic acid, viz.: 62° (solidifies gradually from 47° to 39°.) The crystals gave a small quantity of ash when burned on platina foil, and on being decomposed by hydrochloric acid, gave a fat with the melting point of stearic acid 72° 73°, and solidifying at 60° 55°. The mother liquid contained too little fat to experiment upon. To another portion of the liquid 6°, alcoholic acetate of magnesia was added without addition of acetic acid, and the solution evaporated in a retort. The first crystals which appeared contained a fat which fused at 65°, 68° 5, and solidified at 62°, 58°.

The solid crystalline fat No. 6° which was removed from the liquid 6°, and which was the most highly purified result from the crystallization of this specimen of adipocire, was now examined more particularly; an alcoholic solution was made upon which to try the different experiments. Fifteen grammes of the fat required 300 of alcohol of 93 per cent. to keep it in solution; but before having added so much alcohol, on standing for a short time 0.656 grammes of pearly crystalline scales fell, which had a melting point of 62° 5, and solidified at 55° 5. The fat of the liquid after these crystals had fallen, when precipitated by water, melted at 58° 61°, and solidified at 55° 5: these crystals, re-crystallized from alcohol, melted at 62° 5, and solidified at 58°, 57°; these were dissolved a third time, in twenty times their weight of 93 per cent. alcohol, which deposited, on standing, less than a milligramme of tufted crystals of the form of palmitic acid, of which it had the melting point 62°: more alcohol was added to the solution, and it was divided by fractional precipitation with acetate of magnesia and the addition of a little ammonia with heat, into two portions, weighing 0.256 and 0.164 grammes, and they had the same melting point. This fat appears, therefore, to be palmitic acid, one of the acids into which Heintz divided margaric acid. The crystals deposited from alcohol do not at all resemble those of margaric acid, but under the microscope are lamellar. These two fats were converted respectively, by an excess of nitrate of silver, into silver salts, 0·24725 gave 0·074 Ag. = 29·93 per cent. and 0·14275 gave 0·04175 Ag. = 29·25 per cent., which corresponds to the percentage of silver in the palmitate of this base.

		By calculation.	Mean of two Exper.
C_{32}	192.00		
H_{31}	31.00		
O_4	32.00		
Ag.	107.97	29.7	29.5
	362.97		

There is no doubt, therefore, of the presence of palmitic acid in the fat of human adipocire. The second crop of crystals which fell from the mother liquid of those just examined, contained a fat melting at 62°, in all probability palmitic acid also. A determination of the silver of the salt of this fat was lost in the following curious manner: The silver salt was in lumps, as it had dried on the filter, and after it had stood for a short time at 100 in a watch glass, thinking to facilitate the escape of water, by pulverizing it in an agate-mortar, it became so exceedingly electric, that of the whole quantity of silver salt from 0.651 grammes of fat, I was not able to collect the smallest portion for analysis; whether the powder was attempted to be removed by steel, platinum, glass, a feather, or paper, on the first touch it flew into the air, and alighted upon the table: I have often noticed this behaviour in organic silver salts, and perhaps it would be worth while to try whether one of them could not favourably replace the amalgam on the cushion of the electrical machine.

The following experiments were made upon the alcoholic solution of the fats, from which the above portions of palmitic acid were separated. Enough alcohol was added to this solution to prevent any further deposit by standing, for which, as was before stated, 300 alcohol were required for 15 fat. Its percentage of fat was determined by evaporating the alcohol from a known quantity, and weighing the residue; the melting point of this fat was 60° 5 to 61°. This melting point was again determined after saponification, to ascertain whether a fatty ether might not have been formed, and was found to be the same. The alcoholic solution of acetate of magnesia was also titled so that the necessary quantity might be added to the fat solution by measurement: the fat under consideration should be, by Heintz's experiment, a mixture of stearic and the so called margaric acids, together with impurities.

Before proceeding to the fractional precipitation by acetate of magnesia, the alcoholic fatty solution was treated with an excess of acetate of magnesia, and an excess of acetic acid (aided by a little warmth) added; the resulting liquid was then evaporated over sulphuric acid (removing the crystals as they formed) in order to ascertain what effect this treatment would have upon the melting points. On cooling, a small quantity of a powdery precipitate fell, and after standing for a couple of hours over sulphuric acid, the liquid crystallized rather suddenly, to plates or scales, the melting point of which, after treatment with acid, gave 62°; recrystallized from hot alcohol it melted at 62° 5, 63°.

precipitate the whole, was added; to the filtrate an excess of the magnesia solution was added, and the fat remaining in the filtrate from this precipitation was separated, as was also that of the other two precipitates. The following results and melting points are in their order as determined:

(*a*)	0·351	melts 61°
(*b*)	0·527	" 61°
(*c*)	0·085	" 53°
loss	0·173	
	1.136 grammes.	

(*a*) and (*b*) were united, dissolved in alcohol, enough alcoholic solution of acetate of magnesia to precipitate the half added, and after standing for a couple of days, the precipitate was filtered off, and ammonia added to alkaline reaction to the filtrate. The first magnesia salt was translucent, and fused by heat to a transparent liquid, which by more heat gradually grew darker, finally black, and left a residue of magnesia. The melting point of the fat of this substance was as before, 61°.

The second magnesia salt was white and amorphous; it presented the same relations to heat as the first, and contained a fat of the same melting point, 61°. These fats were both brilliant white, lamellar, and of rough surface. The first magnesia salt contained a per centage of 7·59 MgO (0·25025 gave 0·019) and the second contained about double the per centage of magnesia, viz.: 14·91; for 0·28 salt gave 0·04175 magnesia by incineration.

Neutral palmitate of magnesia C_{32}, H_{31}, O_3 MgO gives by calculation 7·6 per cent. magnesia, and basic palmitate C_{32}, H_{31}, O_3 2 MgO gives 14·15 magnesia, which approaches the nearest to the magnesia salt of the above fatty acids.

The experiments of fractional precipitation of the normal solution of fat 6°, were conducted in the same manner, and with the following results, in which (*c*) and (*d*) represent the fatty acids of the two magnesia salts, and (*e*) that of the portion not precipitated by an excess of acetate of magnesia:

(*c*)	0·474	melt pt. 59° 5
(*d*)	0·440	" 61° 5
(*e*)	0·356	" 58° 5
loss during the ex.	0·010	
	1·280 grammes of fat.	

The magnesia salts from which the fats (*c*) and (*d*) were separated, gave as follows:—(*c*) 0·227 gave 0·01675 = 7·38 per cent. magnesia; and (*d*) 0·1735 gave 0·012 = 6·92 magnesia. On comparing the melting points of these fats, and making allowance for want of a more perfect separation from impurities, there can be little doubt that they are neutral palmitates of magnesia, as was before ascertained. According to Heintz (Zoochemie,

p. 1072,) stearic acid is C_{36}, H_{36}, O_4, and the magnesia salt contains by calculation, 6·9 per cent. of that base. The foregoing experiments upon the two specimens of human adipocire were intended preliminary to a more thorough research into their nature, by Heintz's method; but this process requires such a large quantity of substance in order to effect the separation of small quantities of whatever new acid might be present, and the amount of material dwindled so in the many necessary crystallizations from alcohol to separate the dark-coloured impurities, and especially, since the determinations and reactions already made, were so confirmatory of what has lately been done in working upon the solid fatty acids, I preferred placing aside the substances thus obtained for a future examination, when the separation of fatty acids shall have become more simplified, as it must be before long.

(*c*) *Fossil adipocire of Bison Americanus obtained from a metacarpal bone from Big Bone Lick, by Dr. Leidy.*—It was a white powder, and in pulverizable lumps; amorphous under the microscope; with a talcose feel, and of density a little below 0·8365, since it barely swims upon alcohol of that strength, while it sinks in absolute alcohol. Water will not wet it; with the addition of hydrochloric acid and heat, it is separated without effervescence, into a mineral solution, and into an oil which solidifies on cooling to a nearly white fat, a small portion of which melted on a glass slide solidifies to a confusedly crystalline mass; a small quantity treated in the same way with absolute alcohol, crystallizes in plumose and dendritic crystals, like margaric acid. A portion of the adipocire boiled with absolute alcohol, yields but a minute quantity to the solvent, and that not of a fatty nature, showing that the fatty acid is wholly saponified with an earthy base. The whole quantity of adipocire weighed 0·986 grammes. 0·16325 heated in a platinum crucible, fuses, burning with a smoky flame and with the smell of fatty acid, but no acroleine, leaving 0·0165 or 10·1 per cent. of a perfectly white ash, which hydrochloric acid almost perfectly dissolves without effervescence, and which consists almost entirely of lime, with a few minute specks of oxide of iron (seen during the action of the hydrochloric acid,) and a couple of small grains of sand: there is a very small trace of phosphoric acid present. The greater portion of the adipocire, 0·716 grammes, was decomposed by hydrochloric acid and water, by the aid of heat: the decomposition took place with a strong smell of rancid tallow, and the fundamental smell observed in all adipocire was emitted. It was melted and washed several times, at first with acidulated and finally with pure water. The water from the washing, when evaporated, gave a certain quantity of brownish yellow colouring matter. The fat was melted in the capsule in which the precipitation took place, and weighed 0·618 or 86·31 per cent. of the adipocire; when melted, a dark flocculent humus-like precipitate was seen; the fat itself was yellowish, and of a flat, waxy (here and there warty) surface. It melted at 51°.

The adipocire therefore appears to be a lime soap of one of the fatty acids, with a trace of phosphate of lime and with flocculent organic matter, or in per centage approximatively,

Fatty acids and a little colouring matter, .	86·31
Lime and a trace of phosphate, . . .	10·10
Flocculent organic matter, . . .	3·59
	100·00

If the organic matter be neglected and the per centage then calculated, we will have,

Fatty acids, . .	89·5
Lime, . . .	10·5
	100·0

Now Stearate, Margarate and Palmitate of Lime, respectively contain a per centage of 9·3–9·7—10·2, of lime, so it is reasonable to suppose (as there is nothing in its reaction contrary, but everything favourable to this supposition) that the fossil adipocire is a neutral lime soap of the usual fatty acids of tallow.

Experiments upon the decomposition of muscular fibre (bullock's heart) with water, with a view to the formation of adipocire.

A portion of raw, and one of boiled muscular fibre from bullock's heart, were on March 8th, 1854, placed with water upon a microscope slide, and covered with thin glass, which was closed with sealing wax around the edge to prevent evaporation. This was repeatedly observed during the year, and the attention was directed at times to particular fibres the better to watch any change. At the commencement of the experiment, the cross-markings of the fibre were distinct and the fibre itself was of a delicate rose-colour. I find in my notes of April 8th, and May 11th, that no change presented itself in either the raw or in the boiled fibre, except that the cross-markings were more distinct. On December 6th, 1854, but very little change was noticed, (the raw fibre was whiter,) the cross-markings in both were more distinct than ever; by high powers an amorphous precipitate was discovered in the neighbourhood of some of the fibres—about one third of the water had evaporated.

A. On November 14th, 1853, 100 grammes of cheese were placed in a loosely stoppered bottle, and covered with distilled water, a portion of the same cheese being reserved for comparison: the water was renewed as it evaporated.

B a. On November 19th, 1853, one half of a bullock's heart, weighing 673 grammes, was placed, covered with Schuylkill water, in a wide-mouthed stoppered bottle.

B b. The remaining half of the heart, weighing 816 grammes, was covered with mineral water with lemon syrup. It was intended to use plain mineral water in this experiment, that is, Schuylkill water saturated with carbonic acid, but the former was sent by a

mistake, which was not discovered until too late. In these cases the fat was partially removed from the heart, but not to any great extent.

C. Boiled six eggs, removed the shells from two, which weighed then 88 grammes; ran pin-holes to the centre in two, which weighed 97 grammes, and left the shells upon the remaining two, which weighed 96 grammes; these were together placed in a glass-stoppered bottle, and covered with water. These different substances did not delay to decompose and give out offensive odours, and the eggs especially maintained their proverbial character in this respect; in fact, on the approach of the cholera season I was obliged to place the bottle of eggs on a plate, cover it with a large inverted beaker glass, and heap the rim of the beaker with hypochlorite of lime. With regard to the heart, the contents of the bottle containing mineral water, as might be expected, preserved their lively red colour for a longer time than in the case of the bottles containing river water.

The appearance of these bottles, on December 13th, 1854, was as follows:—

The cheese *A* was converted into a white, thick, grumous mass, lighter than water, and which when diluted with a little water, presented the appearance of pus; under the microscope with moderate power, angular transparent fragments constituted the principal part, and among these, polarized light showed many broken blade-shaped crystals without a play of colours; a few globules of oil were also seen. The material *A* was removed to a glass-stoppered bottle, more water added, and was set aside. A portion of the cheese used in this experiment had been preserved in paper; it was found hard, and on the surface oily. It was placed aside in a cork-stoppered bottle.

B. The bullock's heart had been so divided, that each half contained an auricle and ventricle, which were placed in the bottles, (*a*) with water, (*b*) with carbonic acid water. The appearance of the contents of these bottles at present is similar, though (*a*) seems to be more disintegrated. In both of these, the cavities and valves of the heart maintain, in a measure, their form, and the chordæ tendineæ are in perfect preservation: the serous covering of the heart is consistent; and in (*b*) it is, in parts, quite black from sulphuret of iron. The fluid in both bottles reacts strongly alkaline; when the mass of the heart is cut open, the muscular fibre appears of a dirty, yellowish-red colour, and when examined under the microscope, shows the fibre, but without any of the cross-markings in (*b*.) In (*a*,) which was more disintegrated, by the addition of water and a power of 700 diameters, the fibre could be seen broken in small portions, and giving evident traces of both longitudinal and cross-breaking up of the sarcous substance. The fibres of (*a*,) treated with hot and cold alcohol evinced no change; with hot acetic acid they shrunk in dimensions. The weight of (*a*) dripping with liquid was 330 grammes, that of (*b*) 275 grammes.

C. The Eggs.—The water was strongly alkaline; the shelled eggs were seen in broken,

yellowish-white lumps, and a thick deposit at the bottom of the bottle, gave no evidence of crystallization under the microscope with polarized light. The liquid from the eggs and from the two heart experiments emitted rather a disagreeable odour, which was mingled with an aldehyde smell.

As decomposition had not advanced to its full extent in these bottles, I preferred setting them aside for a future research, when both the solid and the liquid contents will be examined. Braconnot's* analysis of bullock's heart is as follows:—

Water, ...	77·03
Fibrine, cellular tissue, nerves, vessels,	17·18
Albumen and colouring matter of the blood,	2·70
Alcoholic extract and salts, . . .	1·94
Aqueous extract and salts, . . .	1·15
	100·00

ARTIFICIAL FORMATION OF ADIPOCIRE.

On December 8th, 1853, a bullock's heart weighing 1240 grammes, without removing its fat, was buried in sand in an inverted tubulated receiver held in a retort stand, and so placed against the glass that a portion of it could be seen: a reservoir of water was placed above the receiver, and this water was suffered to fall, drop by drop, upon the sand by means of a syphon of lamp-wick. The water was removed when necessary, and the changes appearing in the heart observed. These changes were the same as in the case of the bottled experiments; it began soon to deepen in colour, and on May 11th, 1854, was quite dark, while the liquid falling from the receiver contained a black amorphous precipitate, which is probably, from Liebig's observation of a similar case, sulphuret of iron. A deep zone of green vegetable parasitic matter was visible around the inside of the receiver, commencing within half of an inch above the position of the heart where it was deepest in colour, and thence diminishing as it approached the surface of the sand. On June 7th, the heart was removed and dissected for the purpose of viewing the extent of the decomposition: it maintained its original form, but was larger; the separation of the chambers was apparent; the valves present and the chordæ tendineæ in a perfect state; the greater part of the fleshy walls of the heart was pinkish, soft, of the consistence of lard, of putrid smell, and under the microscope (700 D,) presented an amorphous mass, mingled with fragments of crossed muscular fibre. It was not in as advanced a stage of decomposition as the bottled hearts of December 13th, 1854. The fat which was purposely left around the coronary vessels, was hard, white, and of an appearance approaching that of adipocire. The heart was returned to the vessel and the experiment continued. On my return to

* Ann. de Ch. & de Ph., xvii. p. 390.

the city, after an absence in the summer time, I found that the water reservoir and lamp wick had fulfilled their duty, for the sand was still moist. On December 9th, 1854, the experiment was concluded, and the heart removed from the sand and washed. It was in two pieces, and weighed, when still wet, 219 grammes: after drying in the air for five days it weighed 107 grammes, or 8·6 per cent. of the original weight, and was still moist. This was principally the fat from around the coronary vessels, the impressions of which were on it; the tendinous chords of the valves were perfect, and the valves themselves were indicated. The smell was decidedly tallowish, with the strong smell I have described as adipocire smell, and with the smell of earth worms; all of these odours were plain, and suggested themselves at once to the mind. The fat was hard, and resembled exactly adipocire; it presented a different appearance in two different places: one portion was hard and compact, in some parts denser, in others lighter than water, and appeared granular under the microscope, like the specimens of adipocire already described: the other portion was of a more buttery nature, and of about the density 0·8365. Neither of these specimens gave any traces of fat globules with the microscope, but contained aggregations of white angular fatty matter, of nearly the same size, and about one fourth the diameter of fat globules. With ether the fat disappeared, and left shrunken membranous matter, which after the evaporation of the ether and treatment with acetic acid, became, for the most part, transparent. A comparative experiment with beef fat gave similar results, and I am inclined to think that the most of this matter proceeds from the fat cells,* and their accompanying cellular tissue.

On cutting through the thickest portion of this adipocire, the fat was of a pure white colour, and could not be distinguished from adipocire; in some portions it was nearly an inch in thickness, and at first sight certainly gave the impression that the fleshy walls of the heart were converted into fat; but on closer inspection, this seemed to me improbable. The lumps of adipocire were thickest at the top of the heart, and just where were the lumps of fat in which the coronary vessels were imbedded; moreover, it was the most like adipocire in the centre of those very portions of fat. I obtained the approximate density of the adipocire of this part, by diluting alcohol with water, until the adipocire just swam half way between the surface and the bottom of the liquid, and found it to be 0·8902, which is by experiment lower than that of ox fat. Indeed, as would a priori seem probable, the fat, by the gases evolved during the putrefaction of the proteine bodies, is rendered more porous, and of a lower specific gravity, which deceives the eye, and makes the mass of fat to appear greater than it really is. An ash determination of this part of the adipocire performed upon 1·471 grammes, yielded 0·0015, equal to 0·102 per cent. of a reddish ash, containing iron. No acroleine was observed during this experiment, and no other

* See Kolliker, Mic. Anat., II. 1st Part, page 16.

than the characteristic adipocire smell, which proves the absence of glycerine, and that the fatty acids are uncombined. Ox fat (2·069) gave (0·001, or) a per centage of 0·048 white ash. The iron of the former proceeds probably from the hæmatine in the heart. These ashes are too small in quantity, to arrive at any satisfactory result in ascertaining the nature of their component parts; they appeared by a few tests to contain principally lime, and soda and potash were detected by Smith's test. The melting point of the above portion of adipocire was about 47°, but at 52° the fat still contained a faint precipitate.

The adipocire, on February 3d, 1855, until which time it had been kept in a loosely stoppered bottle, weighed 97 grammes, which is 7·8 per cent. of the original heart. From 91 grammes the fat was separated by boiling it with 317 alcohol, filtering hot, pressing powerfully, and weighing the residue; the latter was bulky, and weighed 40·1, corresponding to 44 per cent. of the *adipocire*, which contains, consequently, only 66 per cent. of fat. If the per centage of fat be calculated from the original weight of the *heart*, it amounts to only 4·4, which is undoubtedly less than was originally in the heart, so that, so far from there being a gain of fat in the formation of the adipocire, there was actually a loss, which accords with the bottle experiments. The alcoholic solution deposited 16·2 grammes of a rather dark fat, which was re-crystallized from 368 grammes of alcohol, and yielded 11 grammes of a lighter fat. I was desirous of retaining a greater portion of this fat for future experiments, and without proceeding to purify it further, obtained its equivalent. It melted between 69°—70°, did not crystallize plainly from alcohol, with which it behaved like stearic acid: a neutral silver salt, deepened in colour considerably when dried at 100°, and gave only 20·59 and 20·68 per cent. of silver. As decomposition had evidently taken place in this salt, the baryta compound was prepared by adding acetate of baryta to the alcoholic solution. The baryta was determined both as carbonate and by converting into sulphate; there was no difference in the two results; the baryta of the carbonate was 0·1701, and that of the sulphate was 0·1700, which corresponds to a per centage of 19·65—stearic acid (Heintz) requires 21·76 per cent., and palmitic acid 23·62 per cent. of baryta for the neutral salts. I have no doubt that a further purification will show this to be stearic acid, as might be expected from the original fat of the heart.

I am not desirous of claiming for these experiments a greater importance than they deserve, nor any but that the experiments were carefully performed: they were extended over the greater part of a year, during which my attention has been particularly directed to this subject. When the investigation was commenced, I was inclined to the belief that adipocire was a result of the decomposition of the blood-forming substances, and this, principally, from the experiments of Blondeau (see first part of this article) which I have not seen refuted, and partly from the testimony of those who have had opportunities of observing the formation of adipocire, and who have stated that fleshy parts of the body

are wholly converted into it. The formation of the lower terms of the series of fatty acids from proteine bodies forbids maintaining that this is impossible; but from what I have seen, and on weighing the evidence of what I have read, my impression is, that adipocire proceeds from the original fat of the body.

It appears to follow from the foregoing experiments, that the higher members of the series of fatty acids do not result from the putrefaction of proteine compounds; at least from such putrefaction as is accompanied by exclusion of air. Flesh fibrine with restriction of air does not putrefy as rapidly as would be supposed, according to the experiment, where a portion was sealed with water on a microscope slide; the air here was not absolutely excluded, since a partial evaporation of the water took place. It is true that the amount of water in this experiment was small, in proportion to the fibrine, and it appears that much water is necessary to such decomposition, and which supports Liebig's theory of the motion of the molecules. In the experiments of the bottles and of the sand, the decomposition was *seen to take place* gradually; the sarcous element of the flesh fibrine separated into discs, and these were by degrees resolved into their simpler compounds, which either remained as liquids or gases in solution in the bottles, or were carried off by the droppings in the sand experiment. The original fat of the body, according to circumstances, either partakes of this decomposition, or else, losing its glycerine and most of its oleic acid, becomes gradually converted into adipocire. In some bodies in the grave yards the fat is totally gone, while in others large quantities of adipocire are formed. It is suggestive that in all cases where adipocire has been found, the corpse was of a large and fat person, and this abundance of fat resists an ultimate decomposition. Analyses by Beetz of candles which had remained for a hundred years in a mine, prove that the only alteration undergone by fats when alone, is destruction of their oleine and glycerine. In the bottles of my experiments no adipocire was formed, although the fat of the coronary vessels was only partially removed; this may be accounted for on the ground that the fat, which was small in quantity, was here kept in close contact with the decomposing fibrine, and suffered with it decomposition, whereas in the sand experiment, this could only take place to a less degree. In grave yards, if the proportion of flesh to fat be large, and especially if the ground be of such a nature as to prevent the decomposed matter being carried off, as by draining, adipocire cannot be formed, but the fat undergoes full decomposition.

The fact that in adipocire from different animals, the same substances are found accompanying the original fat of the animal, as the goat-like or mutton smell in sheep, and the tallow smell of the fossil adipocire, is suggestive, and should shift the burden of experimental proof upon those who maintain the formation of this substance from fibrine. The microscopic experiments militate against the transformation from fibrine. Those that believe in this change think to have proof from the shape, as it were, of certain muscles

transformed into fat; but fibrine does not require to lose much substance in the shape of ammonia, &c., for this transformation, and there would not be, therefore, a great disturbance in the shape of the fibres of muscle; at any rate, it would be reasonable to expect, that with the microscope, traces of an arrangement of the fatty particles into fibres or rows would here and there be seen, but this is not the case, and the appearance is that of fat particles of equal size among themselves, and of a diameter one-fourth that of the original fat globules, and indeed presenting all the appearances to be expected from a mass of fat undergoing alteration from the decomposition of its oleine and glycerine; and finally in the experiment where adipocire was artificially formed, no gain of fat was observed, but a loss of what was purposely left upon the specimen under examination.

I shall delay an examination of the products in my hands, until the separation of the fatty acids is improved. It would be easy enough with the present methods to isolate the two principal constituents of the fatty acids from the material in hand; but small quantities of new products would inevitably escape observation.

The *desiderata* in working the fatty acids at present, are, First, separation of the oleic acid, without too much loss of substance.

Second, a less circuitous method of separating the fatty acids than by Heintz's method, which renders difficult the isolation of small quantities of a different acid, as shown by his mistake of anthropic acid.

It is probable that a crystallization of salts (especially with a base of a high equivalent) would effect this purpose, for in crystallization, other compounds and impurities are concentrated in the mother liquids, while in fractional precipitation, in the present case, an infinite subdivision seems to take place, requiring many steps to accomplish a sufficient purification; and brilliant as Heintz's results are, considerable labour was required to arrive at them. Heintz's process of partial precipitation was founded upon the method of fractional distillation, proposed by Liebig for the separation of the lower members of the series of fatty acids; in the latter case presence of an alkaline carbonate, in quantity insufficient to saturate the mixed acids, alters their volatility, while in the former, presence of a salt in insufficient quantity for perfect decomposition changes the relations of *solubility* of the salt formed, and it does not necessarily follow that the chemical affinity, active in both cases, will afford as *expeditious* a method in cases of solubility as in those of volatility.